APPENDIX 6-8

WATER BALANCE MODEL DOCUMENTATION MEMORANDUM

BLACK & VEATCH

TECHNICAL MEMORANDUM

South Florida Water Management District
EAA Reservoir A-1
Work Order No. 5

B&V Project 141522
B&V File: C-1.3
First Issue: July 8, 2005
Last Updated:

Task 5.3.6.2.2 Water Balance Model Documentation

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Task 5.3.6.2.2 Water Balance Model Documentation

To: Shawn Waldeck, Rich Bartlett

From: Rafael Frias and Jeff Henson

1. OBJECTIVE

The purpose of EAA Reservoir A-1 is to capture Everglades Agricultural Area (EAA) basin runoff and releases from Lake Okeechobee. The facilities should be designed to improve the timing of environmental water supply deliveries to Stormwater Treatment Area (STA) 3/4 and the Water Conservation Areas (WCAs), reduce Lake Okeechobee regulatory releases to the estuaries, meet supplemental agricultural irrigation demands, and increase flood protection within the EAA. (Hornung et al.)

The objective of this memorandum is to provide the necessary information for the development of the Water Balance Model (WBM), including Model Description and Applicability, Model Input and Assumptions, Model Output and Results, and Model Documentation. The information provided herein will help South Florida Water Management District (District) staff understand the WBM and its capabilities for to evaluate specific scenarios for the EAA Reservoir A-1.

2. WATER BALANCE MODEL

2.1 Model Description and Applicability

A water balance analysis is an important technique used to assess the components of a hydrologic and hydraulic system. The WBM was developed for the EAA Reservoir A-1 to analyze its storage capacity and operations on a daily basis (time step). The model is used by the design team in the evaluation of different reservoir alternatives and related facilities, thus increasing the flexibility of the design process.

The WBM may be used to optimize the storage capacity of the reservoir, while evaluating the impacts on flows in the North New River (NNR) canal, Miami canal, and the STA 3/4 supply canal. In addition, the model may be used to evaluate pumping facility locations and the distribution of releases from the reservoir for environmental and agricultural irrigation purposes.

The WBM is maintained in Microsoft Excel and incorporates formulas and Visual Basic programs to calculate changes in storage and stage in the reservoir over the period of simulation (POS). The POS extends for 36 years from January 1, 1965 to December 31, 2000. The size of the model is approximately 60 MB and includes 21 worksheets, which are described in detail in the User's Manual in Section 4. To make the model more user-friendly, a graphical user

interface (GUI) was created to facilitate the input of reservoir characteristics and the display of results. Figure 1 in Appendix 5-25 illustrates the GUI of the WBM.

The EAA A-1 WBM includes the following hydrologic components:

- Direct precipitation into the reservoir (P)
- Inflow through pumps and weirs from the canals (I)
- Outflow through weirs and culverts into the canals (O)
- Net evaporation from the reservoir surface (E)
- Seepage losses (S)
- Change in storage in the reservoir (ΔS)

The basic water balance equation is: $\Delta S = P + I - O - E - S$. This equation accounts for the change in storage in the reservoir based on inflows and outflows and is applied to the model on a daily basis. The water balance analysis is performed in the *Water_Balance* worksheet, the central worksheet of the model. This worksheet includes all the inflows and outflows incorporated into the water balance equation and executes the water balance for the entire POS. A view of the *Water_Balance* worksheet is illustrated on Figure 2 in Appendix 5-25.

2.2 Model Input and Assumptions

The main input parameters into the WBM include precipitation, reservoir inflows and outflows, evaporation, and seepage. These parameters may be separated into Inflows and Outflows of the reservoir. Data on the parameters were provided by the District's Office of Modeling (OOM) and the United States Army Corps of Engineers (USACE) Interagency Modeling Center (IMC), based on simulations using the South Florida Water Management Model (SFWMM).

The provided the available flows in the North New River Canal and the Miami Canal, as well as the required flows to STA 3/4 and the agricultural irrigation demands to be supplied by the reservoir, based on the SFWMM ECP 2010 run. The IMC provided evaporation and precipitation data based on the inputs into the SFWMM.

Additional input information into the WBM includes Reservoir and System Characteristics, which are included in the *Input* section of the WBM GUI. Detailed information on Inflows, Outflows, and Reservoir and System Characteristics is provided in Appendix 5-25.

2.3 Model Output and Results

Output from the WBM includes a series of graphs and reservoir information, such as maximum volume, demands met, and Target WSE. The following sections provide an explanation of each model output.

2.3.1 Graphs

- *Storage vs. Time* – Illustrates the resulting storage provided by the reservoir over the POS. A preview of this graph is included in the main WBM screen.

- *Stage and Water Depth vs. Time* – Illustrates the resulting stage and water depth in the reservoir over the POS. A preview of this graph is included in the main WBM screen.
- *North New River Canal Flows vs. Time* – Illustrates the available flows in the North New River Canal over the POS, as simulated by the in the ECP 2010 run.
- *STA 3/4 Supply Canal West Flows vs. Time* – Illustrates the available flows in the STA 3/4 Canal West, as simulated by the in the ECP 2010 run.
- *Irrigation Demands and Irrigation Demands Met vs. Time* – Illustrates the Irrigation demands to be supplied by the reservoir over the POS, as simulated by the in the ECP 2010 run. In addition, the graph shows the actual irrigation demands met by the reservoir over the POS.
- *STA 3/4 Flows and STA 3/4 Flows Met vs. Time* – Illustrates the STA 3/4 flows to be supplied by the reservoir over the POS, as simulated by the in the ECP 2010 run. The graph also provides the actual Flows to STA 3/4 met by the reservoir over the POS.

2.3.2 Reservoir Information Output

Reservoir information output is provided in the *Output* section of the WBM GUI and includes the following:

- Period of Simulation (POS), days
- Seepage
  - Maximum Total Seepage, cfs
  - Maximum Collected Seepage, cfs
  - Maximum Flow lost to Seepage, cfs
- Reservoir Minimum WSE, ft
- Reservoir Maximum WSE, ft
- Reservoir Maximum Volume, ac-ft
- Number of Days Reservoir is Below Minimum WSE
  - Percentage from POS
- Maximum Number of Consecutive Days Reservoir is Below Minimum WSE
  - Number of months
  - Year Occurring
- Number of Days Flows to STA 3/4 are Met
  - Percentage from POS
  - Percentage of Demand Met by Volume
- Number of Days Irrigation Demands are Met
  - Percentage from POS
  - Percentage of Demand Met by Volume
- Number of Days Reservoir is at Maximum WSE
  - Percentage from POS
- Available Flows in the North New River Canal, cfs
  - Maximum
  - Average
- Available Flows in the STA 3/4 Supply Canal West, cfs

  - Maximum
  - Average
- Target WSE, ft
- Number of Days Reservoir is Over Target Depth / WSE
  - Percentage from POS

2.3.3 Results

WBM results for the scenario of a reservoir with a storage capacity of approximately 190,000 acre-ft at a water depth of 12.1 ft are presented in Appendix 5-25.

3. MODEL DOCUMENTATION

3.1 WBM User's Manual

The WBM is maintained in Microsoft Excel and incorporates formulas and Visual Basic programs to perform the water balance and calculate the changes in storage and stage in the reservoir. The model is approximately 60 MB in size and consists of 21 worksheets. The information provided in the *User's Manual* in Appendix 5-25 is intended to assist the users with the operation of the model.

4. REFERENCES

Hornung, L., Brion, L.M., and A. Prymas, undated, EAA Storage Reservoir Project, Identification of the Tentatively Selected Plan.